NPDES Permit Renewal Issues
Aquatic Life and Wildlife Preservation
Sacramento Regional County Sanitation District
Sacramento Regional Wastewater Treatment Plant
28 April 2010

Background/Purpose

Central Valley Regional Water Quality Control Board (Central Valley Water Board) staff is currently developing the National Pollutant Discharge Elimination System (NPDES) permit renewal for the Sacramento Regional County Sanitation District's (SRCSD) Sacramento Regional Wastewater Treatment Plant (SRWTP) discharge to the Sacramento River. The proposed permit renewal is scheduled to be considered by the Central Valley Water Board for adoption in late 2010. The existing NPDES permit (Waste Discharge Requirements Order No. 5-00-188[1]) regulates the discharge of secondary treated municipal wastewater and allows an average dry weather discharge flow of 181 million gallons per day (mgd) to the Sacramento River, within the Sacramento-San Joaquin Delta (Delta). For the proposed permit renewal, the SRCSD is requesting its permitted average dry weather discharge flow increase to 218 mgd.

The purpose of this issue paper is to identify issues and provide information regarding the NPDES permitting requirements necessary to protect the beneficial uses of the Sacramento River and Delta related to the preservation and enhancement of aquatic life. Detailed discussion regarding aquatic life impacts due to aquatic life mixing zones, ammonia, low dissolved oxygen, thermal conditions, pyrethroid pesticides and whole effluent toxicity is also included. Through public issuance of this paper we are requesting public comments and/or data from interested stakeholders to assist Central Valley Water Board staff in developing tentative NPDES permit requirements for consideration of Central Valley Water Board adoption.

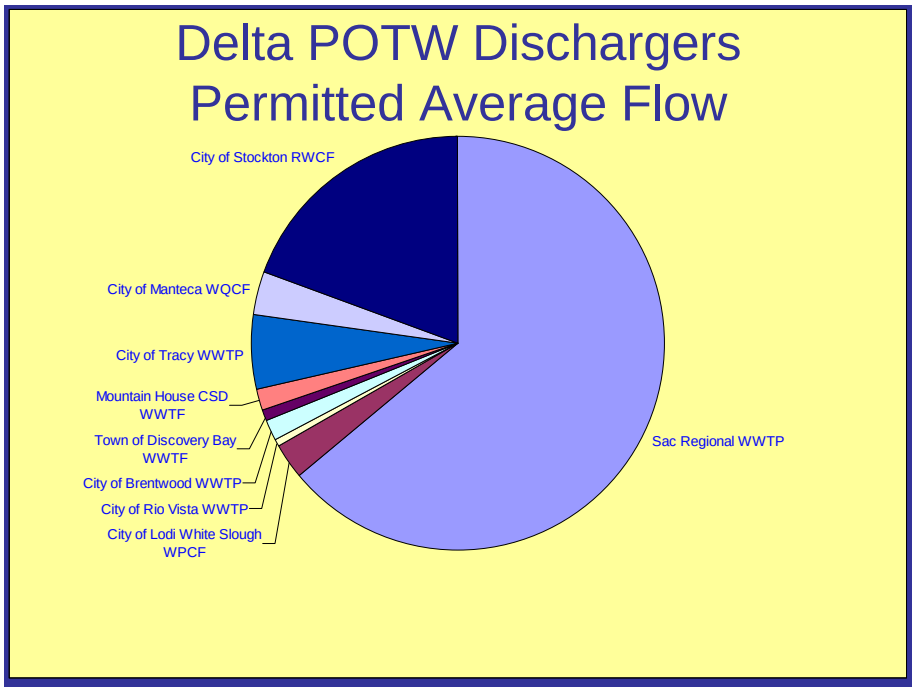
Setting

Sacramento Regional Wastewater Treatment Plant (SRWTP) - The SRWTP is a publicly owned treatment works (POTW) that serves about 1.3 million people in the greater Sacramento area, including the Cities of Folsom, Rancho Cordova, West Sacramento, Sacramento, Elk Grove and Citrus Heights, and urbanized areas of Sacramento County. The SRWTP is located in Elk Grove and discharges disinfected secondary treated wastewater to the Sacramento River immediately below the Freeport Bridge. The existing secondary treatment at the facility consists of preliminary screening and grit removal, primary sedimentation, a pure oxygen activated sludge treatment system, and chlorination for disinfection and dechlorination. The current permitted discharge of the SRWTP is 181 mgd (average dry weather flow) and current flows average 141 mgd. The SRCSD has requested an increase of the permitted average dry weather flow from 181 mgd to 218 mgd to accommodate future growth in the Sacramento area. The SRWTP is a regional facility,

[1]Order No. 5-00-188 was adopted 4 August 2000 and expired 1 August 2005. The SRCSD submitted a complete Report of Waste Discharge and application for renewal on 1 February 2005 The expired permit has been administratively extended until the renewed permit is adopted in accordance with Federal Regulations (40 CFR 122.6)

SRCSD's current permitted discharge of 181 mgd which represents nearly approximately 60% of all POTW discharges to the Delta as shown in Figure 1, below.

Figure 1 – Delta POTW Dischargers based on permitted capacity Average Dry Weather Flow (CVWQCB)



The secondary treated effluent is discharged through a diffuser on the bottom of the Sacramento River where the river surface width is approximately 600 feet wide. The outfall diffuser is approximately 300 feet long with 74 ports and is placed perpendicular to the river flow. At times, due to tidal activity during low flows, the river flows in the reverse direction northeast towards the City of Sacramento. The SRWTP diverts its discharge to emergency basins whenever these conditions exist.

<u>The Sacramento-San Joaquin Delta</u> - The discharge is to the Sacramento River within the Delta. The Delta comprises over 700 miles of interconnected waterways and encompasses 1,153 square miles. The Delta is home to over two hundred eighty species of birds and more than fifty species of fish, making it one of the most ecologically important aquatic habitats in the State. Drinking water for over 25 million Californians is pumped from the Delta via the State Water Project, Central Valley Water Project, and local water intakes. The Delta supports California's trillion dollar economy with $27 billion annually for agriculture. Additionally, the Delta has 12 million user-days for recreation each year.

<u>Beneficial Uses and Water Quality Objectives</u> - The Central Valley Water Board adopted the Water Quality Control Plan for the Sacramento and San Joaquin River Basins (Basin Plan). The Basin Plan designates beneficial uses for the Sacramento River and the Delta. The Basin Plan includes, in part, the following beneficial uses for the Delta: warm and cold freshwater habitat (WARM and COLD), wildlife habitat (WILD), migration of aquatic organisms (MIGR), and spawning, reproduction, and/or early development (SPWN).

To protect these beneficial uses the Basin Plan contains both numeric and narrative water quality objectives. Numeric water quality objectives are included through the Basin Plan's chemical constituents' objective. The Basin Plan also includes the following narrative water quality objectives that relate to preservation and enhancement of fish, wildlife and other aquatic species:

- Water shall not contain biostimulatory substances which promote aquatic growths in concentrations that cause nuisance or adversely affect beneficial uses.

- Chemical Constituents – Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses

- All waters shall be maintained free or toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. (Narrative Toxicity Objective)

The Central Valley Water Board primarily uses aquatic life criteria from the United States Environmental Protection Agency (USEPA) National Toxics Rule, California Toxic Rule, and Recommended National Ambient Water Quality Criteria to implement the Basin Plan's Narrative Toxicity Objective.

Federal Regulations mandate that NPDES permits include effluent limitations for all pollutants that are or may be discharged at levels that cause or have a reasonable potential to cause or contribute to an exceedance of a water quality standard, including numeric and narrative objectives within a standard. Where reasonable potential exists for a pollutant, but there is no numeric criterion or objective for the pollutant, water quality-based effluent limitations (WQBELs) must be established using: (1) USEPA criteria guidance under the Clean Water Act (CWA) Section 304(a), supplemented where necessary by other relevant information; (2) an indicator parameter for the pollutant of concern; or (3) a calculated numeric water quality criterion, such as a proposed State criterion or policy interpreting the State's narrative criterion[2].

Aquatic Life and Wildlife Issues

Delta smelt and several other pelagic fish and aquatic organisms in the Bay-Delta have experienced dramatic and unexpected population declines in recent years. The Interagency Ecological Program (IEP)[3] determined that at least three general factors may be acting individually or in concert to lower pelagic productivity: toxic contaminants; exotic species; and water project operations. An example of the dramatic decline has been observed in the delta smelt, one of the identified pelagic organisms in decline. Delta smelt is a small, slender-

[2] Water Quality Control Plan for the Sacramento River and the San Joaquin River Basins and
40 CFR 122.44(d) (1) (vi) (A), (B) or (C)), or (3).

[3] The IEP consists of ten member agencies: three State agencies (DWR, DFG, and the State Water Board); six Federal agencies (USFWS, USBR, Geological Survey, Army Corps of Engineers, NOAA Fisheries, and U.S. Environmental Protection Agency (USEPA)); and one non-government organization (The San Francisco Estuary Institute (SFEI)). These ten program partners work together to develop a better understanding of the estuary's ecology and the effects of the SWP and CVP operations on the physical, chemical, and biological conditions of the Bay-Delta estuary.

bodied fish with a typical adult size of 2-3 inches that is found only in the Sacramento-San Joaquin Delta. Historically, it was one of the most common species in the Delta, however, the population declined dramatically in the early 1980's. The delta smelt was listed as a threatened species by the U.S. Fish and Wildlife Service in March 1993 and by the California Fish and Game Commission in December 1993. Delta smelt are considered environmentally sensitive because they only live one year, have a limited diet, and reside primarily in the interface between salt and freshwater. In 1993 abundance increased in an apparent response to an increase in available habitat brought about by a wet winter and spring which ended the seven year drought experienced in the 1990s.

The decline of other organisms is illustrated by the 2009 Fall Midwater Trawl (FMWT) survey (www.dfg.ca.gov/delta/projects) that has been conducted for several Pelagic Organism Decline (POD) species since 1967. The 2009 survey shows that delta smelt, and threadfin shad abundance indices are the lowest in FMWT history. The survey additionally shows that the index for longfin smelt and striped bass are the second lowest in history, and the index for the American shad is the third lowest in FMWT history. Only one splittail was recovered in 2009.

Issue 1 – Proposed Mixing Zones and Dilution for Aquatic Life Criteria

SRCSD has requested mixing zones and dilution credits for compliance with acute and chronic aquatic life water quality criteria. The Central Valley Water Board has the discretion to accept or deny mixing zones and dilution credits. During the permit development a determination must be made whether acute and/or chronic aquatic life mixing zones are allowed, and the appropriate sizing of the mixing zones must be determined. Information currently available to Central Valley Water Board staff regarding mixing zones is provided below and is being considered in the development of the NPDES permit renewal. Please provide any comments or additional information you may have to be considered in the development of the permit.

USEPA's Technical Support Document for Water Quality-based Toxics Control (TSD) (USEPA, 1991) defines a mixing zone as follows, "…a mixing zone is an area where an effluent discharge undergoes initial dilution and is extended to cover the secondary mixing in the ambient waterbody. A mixing zone is an allocated impact zone where water quality criteria can be exceeded as long as acutely toxic conditions are prevented." The State Water Resources Control Board's (State Water Board) Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California, 2005, (SIP) provides guidance on mixing zones and dilution credits in establishing water quality-based effluent limitations. Water quality criteria and objectives must be met throughout a water body except within a mixing zone. All mixing zones shall be as small as practicable and must meet specific conditions. The allowance of mixing zones by the Central Valley Water Board is discretionary and can be granted parameter-by-parameter and/or type of criteria (e.g., acute or chronic aquatic life criteria).

Both federal and state guidance include similar mixing zone conditions as follows:

A mixing zone shall not:

(1) compromise the integrity of the entire water body;
(2) cause acutely toxic conditions to aquatic life passing through the mixing zone;
(3) restrict the passage of aquatic life;
(4) adversely impact biologically sensitive or critical habitats;
(5) produce undesirable or nuisance aquatic life;
(6) result in floating debris, oil, or scum;
(7) produce objectionable color, odor, taste, or turbidity;
(8) cause objectionable bottom deposits;
(9) cause nuisance;
(10) dominate the water body or overlap a mixing zone from different outfalls; or
(11) be allowed at or near any drinking water intake.

The size of the mixing zone must be as small as practicable and shall provide a zone of passage to provide non-acutely toxic conditions for passing aquatic life. There are several methods for determining the size of an acute mixing zone. USEPA's TSD suggests that organism float times through a mixing zone less than 15 minutes will satisfy the condition that there will be no lethality to aquatic life[4] . The existing NPDES permit adopted in 2000, prohibits river discharge when the flow ratio (Sacramento River: effluent) is less than 14:1. The critical low flow conditions based on this requirement is 4,700 cfs at a discharge rate of 218 mgd, which results in a velocity of 0.42 feet per second[5]. The 15 minute float time distance at 4,700 cfs is approximately 350 feet below the discharge. Thus a proposed acute toxicity mixing zone size would be limited to a maximum of 350 feet downstream of the discharge based on critical low flow rate conditions and the corresponding flow velocities.

USEPA Region VIII, in its "EPA Region VIII Mixing Zones and Dilution Policy", recommends no dilution for acute aquatic life criteria, stating the following, "In incomplete mix situations, discharge limitations to implement acute chemical-specific aquatic life criteria and narrative (no acute toxicity) criteria shall be based on achieving such acute criteria at the end-of-pipe (i.e., without an allowance for dilution). This approach is intended to implement the narrative requirement prohibiting acutely toxic conditions in the mixing zone."[6] To meet the Basin Plan's narrative requirement to prohibit acutely toxic conditions, the existing permit requires that acute bioassay tests are conducted using 100% effluent. The renewed permit will likely propose the same requirements.

The SIP does not include specific guidelines on the size of mixing zones other than that it must be as small as practicable. Where a mixing zone is allowed, its size and shape will be determined on a case-by-case basis. Other States use either and/or both a maximum distance or cross-sectional area or flow which ever is most stringent. For example, if the mixing zone distance is restricted to 10 times the width of the river, the mixing zone would be

[4] Technical Support Document for Water Quality-based Toxics Control (TSD) (USEPA, 1991) (page 33)

[5] Technical Memorandum, Mixing Zones and the Prevention of Acutely Toxic Conditions, July 13, 2009, Larry Walker Associates

[6] USEPA Region VIII Mixing Zones and Dilution Policy, December 1994 (Updated September 1995), (page 18)

6000 feet for the SRWTP discharge, or where the plume occupies 50 percent of the cross-section of the river. In this circumstance, the proposed mixing zone would be limited to 700 feet downstream of the outfall[7].

An adequate zone of passage is necessary if an acute and/or chronic mixing zone is allowed. There must be a zone of passage for aquatic life to migrate past the effluent plume. The SRCSD developed a dynamic model to evaluate the near-field effects of the discharge. The dynamic model was used to evaluate the zone of passage around the mixing zone where water quality objectives are met. The dynamic model indicates there is a zone of passage for aquatic life, which was verified through dye testing. The size of the zone of passage varies on either side of the river depending on the river geometry[8]. The surface of the river is approximately 600 feet across and the bottom of the river is approximately 400 feet across. Based on the model the zone of passage at the surface of the river is generally at least 100 feet on both sides of the river, while the zone of passage at the bottom of the river is greater than 40 feet from both sides of the river.

The chronic aquatic life mixing zone is sized to protect the water body as a whole and is generally larger than the acute mixing zone. The TSD at page 33 states that, "If the total area affected by elevated concentrations within all mixing zones combined is small compared to the total area of a waterbody (such as a river segment), then mixing zones are likely to have little effect on the integrity of the waterbody as a whole, provided that the mixing zone does not impinge on unique or critical habitats."

USEPA advises that the possible attraction of aquatic life to the plume should be considered. USEPA Region VIII recommends consideration of meeting acute or chronic water quality criteria at the end-of-pipe (i.e., no dilution) where available data support a conclusion that fish or other aquatic life are attracted to the effluent plume. An additional concern is attracting predators that may use the area around the diffuser as a gauntlet for passing aquatic life. The TSD at page 33 states, "While most toxic effluents are repulsive, caution is necessary in evaluating attractive mixing zones of known effluent toxicity, and denial of such mixing zones may well be appropriate." No specific data is known regarding whether aquatic life is attracted to the plume for the SRWTP discharge. However, the area around the outfall is known to be popular for fishing[9].

Parameter-by Parameter Evaluation – A parameter-by-parameter evaluation must be considered when determining whether mixing zones should be allowed. Based on the reasonable potential analysis conducted by Central Valley Water Board staff, the only constituents with which a mixing zone may be needed for the Discharger to comply with meeting aquatic life criteria are copper, cyanide and ammonia. As discussed in Issue 2 and Issue 3, below, ammonia levels in the Delta are a concern due to the toxicity of ammonia and the effect ammonia can have on dissolved oxygen levels. Furthermore, the removal of ammonia is both technically feasible and commonly employed by most dischargers in the

[7] USEPA Region VIII Mixing Zones and Dilution Policy, December 1994 (Updated September 1995), (page 17)

[8] Model Verification Results for FLOWMOD Simulations of SRCSD Effluent Discharge to the Sacramento River at Freeport, November 2007 Field Study, Flow Science

[9] "Localized Mercury Bioaccumulation Study", Larry Walker Associates, March 2008, Figure ES-1.

Central Valley Region. Therefore, whether a mixing zone should be allowed for ammonia must be carefully considered for the SRWTP discharge.

Issue 2 – Ammonia

Elevated ammonia concentrations may cause acute and/or chronic toxicity to aquatic organisms and is an oxygen demanding substance that can decrease oxygen levels in receiving waters. The SRWTP discharges approximately 14 tons of ammonia daily to the Sacramento River at Freeport. Recent POD related hypotheses include that ammonia from the SRWTP maybe; (1) inhibiting diatom primary production in the Sacramento River below the discharge and in the Delta, (2) causing acute and/or chronic toxicity to delta smelt and *Pseudodiaptomus forbesi*, an important food organism for larval and juvenile fish, and (3) causing a shift in the algal community from nutritious species such as diatoms to less desirable forms like *Microcystis*. Studies are underway to address some but not all these hypotheses. Other studies are planned for the near future. None of the results obtained to date indicate that acute ammonia toxicity is contributing to the POD. However, many of the key studies are not yet complete and will not be available in time for consideration by the Central Valley Water Board as part of the SRCSD's NPDES permit renewal. Information currently available to the Central Valley Water Board staff regarding ammonia is provided below and will be considered in the development of the NPDES permit. Please provide any comments or additional information you may have to be considered in the development of the permit.

Ammonia Toxicity – Ammonia can be toxic to aquatic life with the toxicity varying with the species and with the pH and temperature of the water. Numeric water quality criteria to address both acute and chronic toxicity have been developed by USEPA in its "1999 Update of Ambient Water Quality Criteria for Ammonia" (September 1999). The USEPA ammonia criteria are temperature and/or pH dependent and vary based on the presence or lack of presence of salmonids (acute) and early life stages of fishes (chronic). Studies indicate that the Delta waters rarely exceed the USEPA ammonia acute or chronic criteria[10]. However, recent studies on ammonia and the POD of the Delta indicate USEPA's criteria may not be adequately protective of some sensitive resident Delta species [11,12]. Completed acute toxicity studies also indicate that ammonia downstream of the discharge is not at levels that are acutely toxic to delta smelt or two of its main food organisms, *Eurytemora affinis* and *Pseudodiaptomus forbesi* (invertibrates), but there are indications that additive or synergistic effects are occurring in the SRWTP effluent where ammonia may be combining with other

[10] Engle, D, "Total Ammonia and Unionized Ammonia Concentrations in the Delta; an Examination of Ambient Concentrations and Toxicity Thresholds" presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

[11] Johnson, M. L. "Species Sensitivity Distributions and Exposure Concentrations; Placing Recent Results in Context", presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

[12] Teh, S.J., "Acute Toxicity of Ammonia, Copper, and Pesticides to Key Copepods, *Pseudodiaptomus forbesi* and *Eurytemora affinis*, of the San Francisco Estuary", presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

unknown toxicants resulting in toxicity[13]. The study evaluated parallel toxicity tests using Sacramento River water seeded with ammonium chloride and another seeded with SRWTP effluent to match the same ammonia concentrations. The study showed that the test performed with SRWTP effluent was statistically more toxic than the test performed with river water seeded with ammonium chloride. This may be an indication that there are additional toxicants present in the SRWTP effluent that are resulting in chronic toxicity to delta smelt. In these toxicity tests, the chronic toxicity of the discharge, based on survival, was 11 TUc (as 100/no observed effect concentration). Funding has been granted to conduct additional testing to confirm the results. The new study will conduct three additional tests in the same manner as the original test. In addition to testing with delta smelt, juvenile rainbow trout will also be used.

Additional studies are underway to evaluate chronic toxicity to a representative smelt food organism (*Pseudodiaptomus*) and to determine the range of acute, no effect level and low effect level for the unknown smelt contaminant in the effluent. *Pseudodiaptomus* results should be available by the end of April but the unknown toxicity paper will not be complete until late summer 2010.

USEPA is in the process of updating its ammonia criteria. USEPA released the "Draft 2009 Update Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater" in December 2009. These criteria would update the 1999 Ammonia criteria currently relied upon by the Central Valley Water Board to develop ammonia effluent limitations to implement the Basin Plan's narrative toxicity objective. The major change to the criteria is the addition of more stringent ammonia chronic criteria specific to freshwater mussels. Table 3 below compares the most stringent 1999 criteria (fish early life stages present) to the proposed 2009 chronic ammonia criteria for freshwater mussels.

Table 3 Temperature and pH-Dependent Values - Ammonia Chronic Criterion: USEPA Ammonia Criteria 1999 Fish Early Life Stages Present to Proposed 2009

	Temperature, °C					
pH @ 7.5	**14**	**16**	**18**	**20**	**22**	**24**
1999	4.36	3.97	3.49	3.06	2.69	2.37
2009	0.933	0.82	0.721	0.634	0.577	0.49

Comments for the proposed 2009 criteria were due to USEPA by 1 April 2010. Currently, there is no projected date for adoption of USEPA's proposed new criteria.

Based on unpublished studies by Dr. Jeanette K. Howard[14] freshwater mussels are located in the Sacramento Basin about 100 miles upstream of the SRWTP and below in the Sacramento Deepwater Ship Channel. No information is available about mussel distribution in the Sacramento River immediately above or below the discharge.

[13] Werner, I, "Effects of Ammonia/um and Other Wastewater Effluent Associated Contaminants on Delta Smelt", presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

[14] Personal Communications with Dr. Jeanette Howard, March 10, 2010 with Chris Foe, CVWQCB and March 17 and 18, 2010 with Kathy Harder, CVWQCB.

Recent studies[15]completed by Dr. Swee Teh, of the University of California, Davis, indicate Delta copepods (Delta smelt food), *Pseudodiaptomus forbesi* and *Eurytemora affinis* are very sensitive to combined concentrations of ammonia and copper. Dr. Teh conducted a pilot study on acute ammonia toxicity with the copepods, an important food species for delta smelt and other larval fish, and found ten percent mortality. Toxicity was observed at 7.56 mg/L total ammonia at pH of 7.6, which is a typical pH for the Delta. Ambient ammonia concentrations in the Delta are significantly lower than 7.56 mg/L outside the immediate vicinity of the outfall. Full life cycle testing is underway with *Pseudodiaptomus* to determine chronic ammonia sensitivity. Results should be available by the end of April 2010. These data will help determine whether ammonia from the SRWTP has the potential to cause chronic toxicity in the Delta.

Inhibition of Phytoplankton Primary Production – Field monitoring demonstrates that algal biomass in the Sacramento River is generally low and decreases from above the effluent discharge to Rio Vista[16,17]. Algae experiments indicate that ammonium discharged from the SRWTP inhibit nitrate uptake, but do not reduce primary production rates in the River below the SRWTP. Other studies suggest that ammonia levels in Suisun Bay (about 50-miles downstream from the plant) reduce both nitrogen uptake and primary production rates[18]. It is unknown what the impact of ammonia is in the freshwater Delta between the SRWTP discharge and Suisun Bay. It is also unclear at present why algal biomass is decreasing in the lower Sacramento River. Studies are underway to evaluate the impact of elevated ammonia levels from the SRWTP discharge on algal primary production rates in the Delta. Study results for primary production in the Delta should be available in about a year.

Shift in Algal communities - In the last several years, annual blooms of *Microcystis sp.* have been reported in the Delta. High concentrations of *Microcystis sp.* produce taste and odor problems for humans drinking the water and can be toxic to zooplankton. A hypothesis is that the elevated concentrations of ammonia in the Delta are responsible for shifting the competitive advantage to less nutritious bluegreen algae such as *Microcystis* in late summer. *Microcystis* abundance appears to be positively correlated with ammonium, but microcytins (the toxic chemical produced by *Microsystis*) does not appear to be correlated with ammonium[19]. However, the data collected to date is ambiguous. A recent study by Dr. Lehman[20], of the Department of Water Resources (DWR), indicates *Microcystis* cell

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[15] Teh, S.J., "Acute Toxicity of Ammonia, Copper, and Pesticides to Key Copepods, *Pseudodiaptomus forbesi* and *Eurytemora affinis*, of the San Francisco Estuary", presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

[16] Foe, C.A. "Preliminary Ammonia Results from an Ongoing Monitoring Program", presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

[17] Parker, A.E. "Effect of Wastewater Treatment Plant Effluent on Algal Productivity in the Sacramento River Part 2: Transect Results" presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

[18] Parker, A.E. "Effect of Wastewater Treatment Plant Effluent on Algal Productivity in the Sacramento River Part1: Grow Out and Wastewater Effluent Addition Experiments" presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

[19] Mioni, C. E,, "Does Ammonia Impact the Distribution of Harmful Algae and Phtotoxins in the San Francisco Estuary?" presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

[20] P.W. Lehman, G. Boyer, M. Satchwkll, S. Waller “The Influence of Environmental Conditions on the Seasonal Variation of *Microcystis* cell density and microcystins concentration in the San Francisco Estuary” Hydrobiologia (2008) 600:187-204.

density increases primarily through low stream flow and high temperature. Nutrient concentration and nutrient ratios (i.e., nitrogen to phosphorus ratios) are secondary factors to increased *Microcystis* growth.

Some questions still remain. If there is a shift in the algal community how does that affect other aquatic life? Does the *Microcystis* change or shift the aquatic communities due to its toxins or nutritional value? If there are shifts in the aquatic communities is this an impairment of aquatic life beneficial uses? Additional information on nutrients is included in the Drinking Water Supply and Public Health issue paper, which has been posted on the Central Valley Water Board website at:

http://www.waterboards.ca.gov/centralvalley/board_decisions/tentative_orders/index.shtml#srcsd

To date, the ammonia studies discussed above do not confirm or refute ammonia as a cause of the POD. However, ammonia is a significant issue for this discharge and must be addressed in the NPDES permit renewal. The average ammonia concentration in SRWTP effluent is 24 mg/L. Continued discharge of ammonia at this concentration will require granting of acute and chronic mixing zones. Effluent limitations for ammonia are not included in the existing NPDES permit for the SRWTP discharge, due to dilution in the Sacramento River. Ammonia removal is technically feasible, but would require major modifications at the SRWTP.

Issue 3 – Low Dissolved Oxygen

The Basin Plan includes a water quality objective for dissolved oxygen of not less than 7 mg/L for portions of the Delta, including the Sacramento River in the vicinity and downstream of the SRWTP discharge. Several water quality databases include dissolved oxygen water quality data showing the Sacramento River below the SRWTP discharge has been at times out of compliance with the Basin Plan's dissolved oxygen water quality objective while the river upstream of the SRWTP is always in compliance. Dissolved oxygen is an issue that must be address in the NPDES permit renewal for the SRWTP due to the oxygen demand from the SRWTP, the possible low dissolved oxygen issues in the Sacramento River, and the proposed wastewater treatment plant expansion. Information currently available to the Central Valley Water Board staff regarding dissolved oxygen is provided below and will be considered in the development of the NPDES permit. Please provide any comments or additional information you may have to be considered in the development of the permit.

The SRWTP discharges oxygen demanding substances, such as biochemical oxygen demand (BOD) and ammonia. Current SRWTP BOD concentrations average 7.5 mg/L and the average effluent ammonia is 24 mg/L (as Nitrogen). SRCSD is currently evaluating the effect of the SRWTP discharge on the dissolved oxygen in the receiving water[21]. Initial results indicate the expanded discharge will cause the dissolved oxygen in the Sacramento River to be less than the Basin Plan water quality objective if effluent ammonia and BOD remain at present concentrations.

[21] "Administrative Draft - Low Dissolved Oxygen Prevention Assessment", 20 May 2009, prepared by Larry Walker and Associates. Substantial revisions to this report are being made to respond to Regional Board comments.

Dissolved oxygen ambient monitoring data downstream of the SRWTP discharge has demonstrated that at times the Sacramento River is not in compliance with the Basin Plan objective. DWR maintains several water quality databases for locations in the Delta. The California Data Exchange Center (CDEC) collects hydrologic data from many state, federal and local agencies. The Hood monitoring station (eight miles below the SRWTP discharge) collects water quality data including continuous monitoring for dissolved oxygen on 15 minute intervals. The station is checked every two weeks for accuracy and is calibrated, as needed. Since 2008, at times the dissolved oxygen concentrations have been recorded below 7.0 mg/L at the Hood monitoring station. The Municipal Water Quality Investigations (MWQI) a separate unit at DWR, also collects dissolved oxygen water quality data at Hood. The MWQI database also shows dissolved oxygen concentrations below 7.0 mg/L at Hood. Central Valley Water Board staff has conducted a nutrient study for the last year and also recorded dissolved oxygen concentrations below 7.0 mg/L at several locations downstream of the SRWTP discharge, including Hood.

At the expanded discharge it may be necessary to reduce the effluent BOD and/or the ammonia concentrations to maintain compliance with the dissolved oxygen water quality objective. To reduce the effluent ammonia concentration, SRCSD is examining operational changes such as eliminating the high ammonia leachate from the sludge lagoons that is treated at the SRWTP. Other options for reducing BOD or ammonia have not been presented by SRCSD.

Issue 4 – Thermal Conditions

The existing NPDES permit allows for an exception to the thermal conditions required by the Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan). The SRCSD has requested an increase in regulated flow from 181 million gallons per day (mgd) to 218 mgd and requested an another Thermal Plan exception. Information currently available to the Central Valley Water Board staff regarding thermal conditions is provided below and will be considered in the development of the NPDES permit. Please provide any comments or additional information you may have to be considered in the development of the permit.

The SRWTP discharges to the Sacramento River via a 400-foot outfall (300-foot diffuser with 74 ports) that is placed on the bottom of the river perpendicular to the river flow. The Sacramento River in the vicinity of the discharge is approximately 600 feet wide at the surface, about 400 feet wide at the bottom and 25 feet deep. The Sacramento River at the point of discharge experiences tidal flows that slow the river flow, and at times cause flow reversals. The existing NPDES permit adopted in 2000 (Order No. 5-00-188), prohibits river discharge when the flow ratio (Sacramento River: effluent) is less than 14:1. The existing permit also prohibits discharge when river flows are less than 1,300 cubic feet per second (cfs). These discharge prohibitions are based on the design of the outfall diffuser to ensure adequate mixing of effluent with river water. When either of these two conditions exists, the SRCSD ceases its surface water discharge and diverts treated effluent to storage basins.

The SRCSD submitted a study assessing the thermal impacts of its discharge in the Sacramento River to the National Marine Fisheries Services (NMFS), titled “Thermal Effects

of Sacramento Regional Wastewater Treatment Plant Discharges on Migrating Fishes of the Sacramento River, February 2005." The 2005 Thermal Study was previously reviewed by NMFS staff and they did not indicate any concerns with the proposed Thermal Plan exception. Since this time, however, conditions under which the evaluation was made have changed. There has been a significant pelagic organism decline in the Delta, new species are threatened, and there has been a change in the diffuser configuration. SRCSD has contracted with a fisheries biologist that is currently developing additional information regarding the SRWTP's thermal discharge to assist NMFS in its evaluation of the discharge. NMFS is currently reviewing the revised Thermal Plan exception request.

Table 4 below outlines the Thermal Plan requirements, the Thermal Plan exception allowed in the current NPDES permit, and SRCSD's proposed Thermal Plan exception request for the NPDES permit renewal at the increased flow.

Table 4 - Existing and Proposed Thermal Plan Exception Requirements

Thermal Plan Requirements (Section 5.A.(1)a-c)	Existing NPDES Permit Requirements (181 mgd discharge)	SRCSD Proposed NPDES Requirements (218 mgd discharge)
5.A.(1)a The maximum effluent temperature shall not exceed the natural receiving water temperature by more than 20^{o}F	The maximum temperature of the discharge shall not exceed the natural receiving water temperature by more than: • 25^{o} F from 1 October through 30 April; -or- • 20^{o} F from 1 May through 30 September *(meets Thermal Plan requirements)*	The maximum temperature of the discharge shall not exceed the natural receiving water temperature by more than: • 28^{o} F 1 November through 31 January • 25^{o} F 1 February through 31 March • 25^{o} F 1 October through 31 October • 20^{o} F from 1 April through 30 Sept
5.A.(1)b Elevated temperature waste discharges either individually or combined with other discharges shall not create a zone, defined by water temperatures of more than **1^{o}F** above natural receiving water temperature, which exceeds 25 percent of the cross-sectional area of a main river channel at any point.	If the natural receiving water temperature is less than 65º F:The discharge shall not create a zone, defined by water temperature of more than **2^{o} F** above the natural receiving water temperature, which exceeds 25 percent of the cross sectional area of the River at any point outside the zone of initial dilution. If the natural receiving water temperature is 65º F or greater: Meets Thermal Plan requirements at any point outside the zone of initial dilution.	Drop provision **5.A.(1)b** and replace with: The discharge shall not create thermal conditions within the river that prevent fishes from migrating past the diffuser
5.A.(1)c No discharge shall cause a surface water temperature rise greater than 4^{o}F above the natural temperature of the receiving waters at any time or place.	No Exception (*Meets Thermal Plan Requirements)*	No Exception (*Meets Thermal Plan Requirements)*

Issue 5 – Pyrethroid Pesticides

A recent study[22] to identify sources of pyrethroid pesticides in the Sacramento-San Joaquin Delta shows, that although minimal toxicity was detected in the Sacramento River, SRWTP effluent contained pyrethroid pesticides in concentrations that may be toxic. Information currently available to the Central Valley Water Board staff regarding pyrethroid pesticides is provided below and will be considered in the development of the NPDES permit. Please provide any comments or additional information you may have to be considered in the development of the permit.

[22] Weston, Donald P and Michael J. Lydy, "Urban and Agricultural Sources of Pyrethroid Insecticides to the Sacramento-San Joaquin Delta of California", Environmental Science Technology 2010, 44, 1833-1840.

Nearly one million pounds of pyrethroid insecticides are widely used by professional pest control firms, farmers and residents in California to control insects. Some fraction of these pesticides often ends up in waterways. Dr. Donald Weston conducted a study in 2008/2009[26], and collected samples from 8 agricultural pumps, 6 urban storm drains and 3 municipal wastewater treatment plants from three communities, Sacramento, Stockton and Vacaville to better understand the source of pyrethroids. Dr. Weston found that virtually all urban runoff from the three urban areas studied contained pyrethroids, typically at four times the concentration that is found to be toxic to the toxicity test species (i.e., paralyze *H. azteca)*. Approximately two-thirds of the undiluted effluent samples from the wastewater treatment plants contained detectable pyrethroids, typically at about 0.5-1.5 times the concentrations that would be expected to cause toxicity. In every sample of the SRWTP, at least 70 percent of the organisms were dead or unable to swim. Pyrethroids were detected in 4 of 6 SRWTP samples. Vacaville's Easterly Wastewater Treatment Plant showed toxicity in 33% of its samples, but no toxicity was found in Stockton's Regional Wastewater Control Facility effluent samples. Approximately ten percent of agricultural runoff samples tested were toxic, and in every case, could be linked to the pyrethroid lambda-cyhalothrin or the organophosphorus pesticide, chlorpyrifos.

Dr. Weston also found repeated toxicity, linked to pyrethroids, in the American River after several storm events. Pyrethroid pesticides were detected in the Sacramento River and San Joaquin River, but the two rivers rarely tested toxic. Dr. Weston suggests at current flows, SRWTP discharges on average 9 grams per day (g/d) of pyrethroids in the dry season and 13 g/d during the wet season. At this time, the fate of the mass loading of pyrethroids from the SRWTP is unknown.

Issue 6 Whole Effluent Toxicity

Delta waterways are impaired for unknown toxicity. The contaminants from point and non-point sources, complex mixes of contaminants and other stressors may all be contributing to the toxicity. The toxicity of municipal wastewater discharges is measured through whole effluent toxicity testing. Whole effluent toxicity (WET) is defined as the aggregate toxic effect of an effluent measured directly by an aquatic toxicity test. Information currently available to the Central Valley Water Board staff regarding whole effluent toxicity is provided below and will be considered in the development of the NPDES permit. Please provide any comments or additional information you may have to be considered in the development of the permit.

Acute Toxicity – The current permit requires the SRCSD to conduct weekly 96-hour continuous flow-through acute bioassays using 100% effluent. The limits require 70% survival for fathead minnows of any one bioassay and median result of 90% survival with three or more consecutive tests. Recent flow through bioassays conducted by the SRCSD during regular effluent monitoring show intermittent toxicity, but the cause is unknown. Additionally, the ammonia studies for the Delta by the University of California at Davis (UCD)[23] showed toxicity by unknown contaminants in the SRWTP effluent (see section on ammonia).

[23] Werner, I, "Effects of Ammonia/um and Other Wastewater Effluent Associated Contaminants on Delta Smelt", presented at the 18-19 August 2009 Ammonia Summit at the Central Valley Regional Water Quality Control Board.

From February 2008 through December 2009, SRWTP effluent has exceeded the acute toxicity effluent limitations in 15 out of about 100 bioassays. The acute toxicity is demonstrated in the effluent with 11 violations of the median result of 90% survival of any three consecutive flow through bioassays and 4 violations of the less than 70% survival of any one bioassay.[24] No dilution has been allowed in the current NPDES permit for compliance with the acute WET effluent limits. This is consistent with recommendations by USEPA[25].

USEPA's acute whole effluent toxicity testing method specifies that either *Oncorhynchus mykiss* (rainbow trout) or fathead minnows may be used as the testing species. In recent NPDES permits for Delta dischargers adopted by the Central Valley Water Board, the use of the more sensitive rainbow trout is required in the acute bioassays, since the Delta waterways are a migratory corridor for salmon and steelhead. Since the current permit requires fathead minnows as the test species for conducting acute bioassays, impacts may be under estimated for more sensitive resident species in the Delta, such as salmonids. The NPDES permit renewal will consider the use of rainbow trout in the acute bioassays, because Rainbow Trout have been shown to be as sensitive to ammonia as delta smelt, whereas Fathead minnows are less sensitive. However, it is uncertain whether Fathead minnows may be more sensitive to other toxicants in the SRWTP effluent. Additional testing by UCD will be performed this year to evaluate this further.

It may also be appropriate to required additional acute toxicity testing using *Hyalella azteca*, a Delta resident amphipod that is an epibenthic organism typically used for sediment testing. *Hyalella azteca* is a very sensitive species as determined by Weston[26] with pyrethroid toxic concentrations as low as 2 ng/L in surface waters. Using *Hyalella azteca* has the benefit of determining potential toxicity in both the water column and the sediment and may provide data to determine the contaminants that may be causing unknown toxicity in the Delta.

Chronic Toxicity – Four permitting issues associated with chronic toxicity for the SRWTP discharge are discussed below. The issues are: (1) the methods of calculating the magnitude of chronic toxicity, (2) the appropriate dilution water to be used for chronic WET testing, (3) whether the permit should include numeric or narrative effluent limits for chronic toxicity, and (4) the magnitude of chronic toxicity that triggers further evaluation.

Chemical-specific effluent limits are required in NPDES permits based on established water quality criteria to ensure the effluent is not toxic and beneficial uses are protected. However, the combinations of individual toxicants in effluents can have synergistic or additive toxic effects that may not be accounted for through the regulation of chemical-specific effluent limits. Therefore, chronic WET testing is also required to ensure the effluent is not toxic. USEPA has established the test method for measuring chronic toxicity in effluents and

[24] 1 July 2009 and 12 January 2010 Notices of Violations to Ms. Mary Snyder from Mr. Victor R. Vasquez, Senior Engineer for the NPDES Compliance and Enforcement Unit, Central Valley Regional Water Quality Control Board

[25] USEPA Region VIII Mixing Zones and Dilution Policy, December 1994 (Updated September 1995), (page 13)

[26] Weston, Donald P and Michael J. Lydy, "Urban and Agricultural Sources of Pyrethroid Insecticides to the Sacramento-San Joaquin Delta of California", Environmental Science Technology 2010, 44, 1833-1840.

receiving waters[27]. Exposure duration for short-term chronic toxicity tests is 7 days, with lethal and sublethal biological endpoints measured (e.g., survival, growth, or reproduction). Test species required in the EPA test method for the chronic test are *Pimephales promelas* (fathead minnows), *Ceriodaphnia dubia* (water flea) and *Selenastrum capricornutum* (algae). The test is conducted using a dilution series, which is a series of a minimum of five effluent concentrations where the effluent is diluted with either the upstream receiving water or synthetic dilution water.

(1) Hypothesis Testing vs Point Estimate – The magnitude of chronic toxicity is measured in chronic toxic units or TUc. There are two methods for measuring the magnitude of toxicity, hypothesis testing or the point estimate. The objective of chronic WET testing is to determine the effluent concentration at which there is no toxicity. For hypothesis testing, the highest effluent concentration that is not toxic is the no observed effect concentration (NOEC). The NOEC is the highest concentration of the effluent where there is no statistically significant effect compared to the control. The resulting magnitude of chronic toxicity determined through hypothesis testing is equal to100 times the reciprocal of the NOEC (i.e., TUc = 100/NOEC). Point estimate procedures are used to estimate an effluent concentration that would cause an observable adverse effect (e.g., reduced growth) in a given percentage of test organisms. The point estimates are derived from a mathematical model (e.g., Probit Analysis, Spearman-Karber Method, etc.) that assumes a continuous dose-response relationship. The chronic endpoint that is similar to the NOEC for hypothesis testing is the effect concentration (e.g., EC_{25}). The EC_{25} is a point estimate of the toxicant concentration that would cause an observable adverse effect in 25 percent of the test organisms. The magnitude of chronic toxicity determined through the point estimate is equal to100 times the reciprocal of the EC_{25} (i.e., TUc = $100/EC_{25}$).

An advantage of hypothesis testing is that it returns the no toxicity "safe level" directly, rather than estimating the concentration. A disadvantage of hypothesis testing is the result is reliant on the selected dilution series. The true effect level may lie between the NOEC and the lowest observed effect concentration (LOEC). For example, if the NOEC is 25% and the LOEC is 50% the actual NOEC may lie somewhere between these concentrations. Consequently, it is difficult to develop precise results using hypothesis testing. On the other hand, the point estimate results in a more precise estimation of the true effect level, because all information from the dose-response relationship is used. In addition, with the point estimate effluent variability can be calculated and USEPA recommends using the point estimate when conducting the reasonable potential analysis for WET[28]. A disadvantage of the point estimate method is that an assumed level of adverse effect must be deemed "safe" for the protection of aquatic life.

In recently adopted NPDES permits, the Central Valley Water Board has used hypothesis testing for determining compliance with WET requirements. The reason hypothesis testing is used is that it results in the effluent concentration that shows no toxicity, which indicates definitive compliance with the Basin Plan's narrative toxicity objective. The use of hypothesis testing is also consistent with other Central Valley Water Board WET policies (e.g., irrigated

[27] Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Fourth Edition October 2002 (EPA-821-R-02-013)

[28] Technical Support Document for Water Quality-based Toxics Control (EPA/505/2-90-001, page 6)

lands). In situations of no dilution, the use of hypothesis testing is a good method to evaluate compliance with the Basin Plan's narrative toxicity objective. This is because when there is no dilution the 100% effluent should not be toxic and is demonstrated through hypothesis testing at the 100% effluent concentration. However, in situations where dilution has been allowed for chronic toxicity criteria, the point estimate may be a better method for determining compliance. The point estimate provides a more precise measurement of the magnitude of toxicity, which is needed when some level of effluent toxicity is allowed due to an approved mixing zone.

(2) Dilution Water – The USEPA chronic WET testing method manual recommends that chronic toxicity tests are run with a dilution series with a minimum of five dilutions; for example 100%, 50%, 25%, 12.5% and 6.25% effluent. Upstream receiving water or synthetic laboratory water can be used as the diluent. The current permit requires ambient water upstream of the discharge to be used as the diluent. SRCSD requests a change to synthetic water as the diluent because the upstream receiving water may be toxic. The use of synthetic water allows for determining the absolute toxicity of effluent and consistent dilution water is preferred for TIE determinations. However, using ambient water as the diluent allows for identification of synergistic, additive or antagonistic characteristics when the effluent mixes with the receiving water, thus can provide a better description of the toxic effects of the discharge in the receiving water. USEPA[29] recommends using ambient water for chronic toxicity tests if the objective is to determine additive or mitigating effects of the effluent to already contaminated receiving water as well as estimate the chronic toxicity of the effluent in uncontaminated receiving water. If the objective is to estimate the absolute chronic toxicity of the effluent, USEPA recommends using synthetic water as the diluent. The current NPDES permit requires chronic bioassays using upstream and downstream samples that take into account any toxicity in the ambient water. If the receiving water is toxic, the use of synthetic dilution water is allowed. This is consistent with recently adopted permits for the Central Valley Water Board.

[29] U.S. Environmental Protection Agency (EPA). 2002 Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Freshwater Organisms. Fourth Edition. Office of Water, EPA-821-R-02-013. October.

(3) Numeric or Narrative Effluent Limits – Based on chronic WET testing, the discharge has a reasonable potential to cause or contribute to an in-stream exceedance of the Basin Plan's narrative toxicity objective. In these instances, the State Water Board in WQO 2003-012 for the Los Coyotes and Long Beach Wastewater Reclamation Plant, and reiterated in WQO 2008-0008 for the City of Davis Wastewater Treatment Plant, ruled the following[30]:

"In Order WQO 2003-012, we stated our intent to update the SIP to address chronic toxicity numeric effluent limitations. State Water Board staff is currently working with U.S. EPA to develop reliable toxicity tests and to use sound science in developing a policy…pending adoption of a policy, it was not appropriate to include final numeric effluent limitations for chronic toxicity in NPDES permit for publicly owned treatment works, but that permits must contain the following:

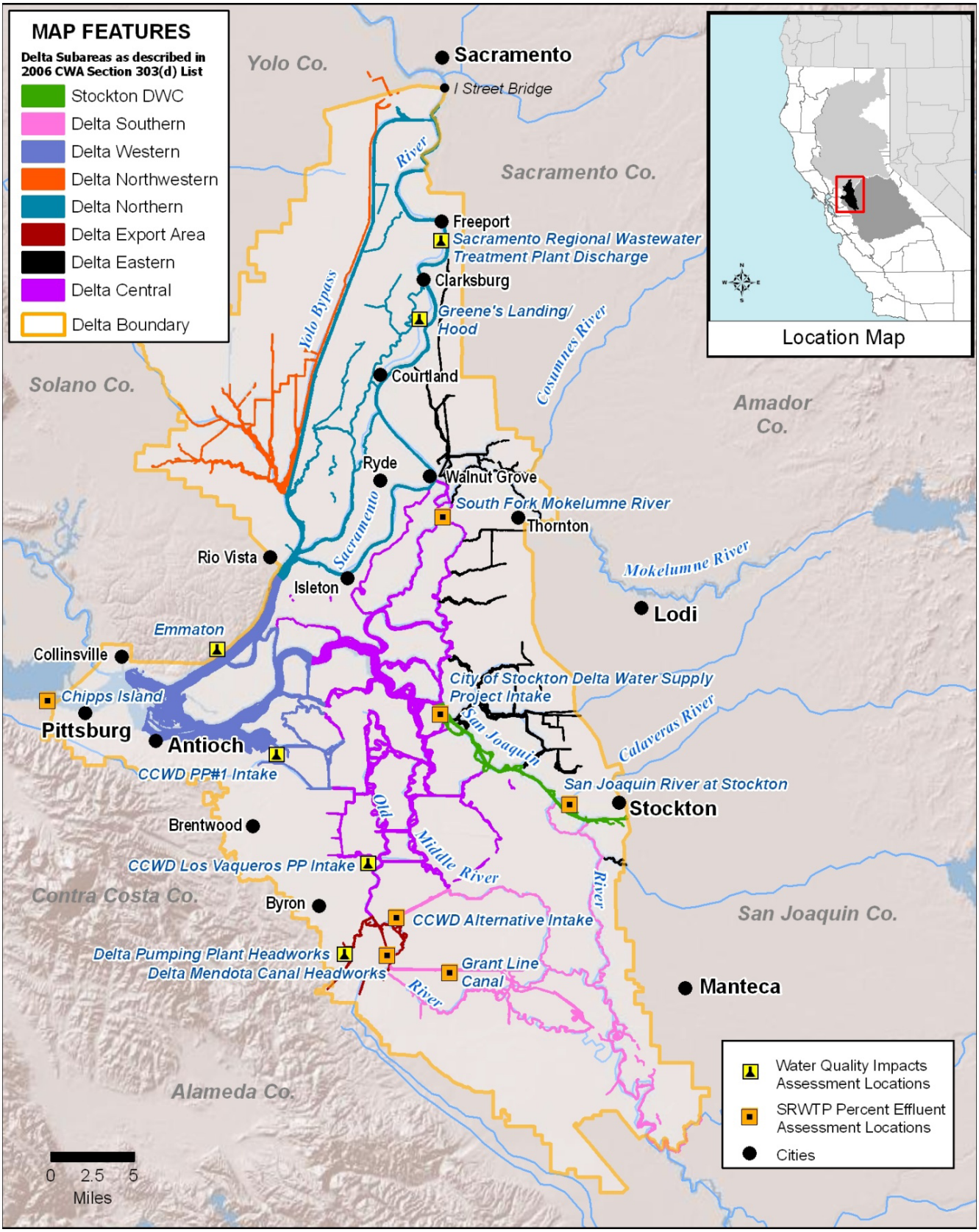
1. A narrative limit such as: 'There shall be no chronic toxicity in the effluent discharge;'
2. Numeric benchmarks for triggering accelerated monitoring;
3. Rigorous toxicity reduction evaluation/toxicity investigation evaluation conditions; and
4. A reopener to establish numeric effluent limitations for either chronic toxicity or the chemical(s) causing toxicity."

Based on the State Water Board's recommendations, a narrative effluent limitation for chronic toxicity is recommended for the permit renewal with a numeric trigger that, if exceeded, will require the SRCSD to initiate additional evaluation.

(4) Numeric Toxicity Trigger – In compliance with the State Water Board's recommendations in WQO 2003-012 and WQO 2008-0008, discussed above, it is recommended that the proposed permit include a numeric toxicity trigger that requires further toxicity evaluation, if exceeded. Current NPDES permits include a special provision that requires Dischargers to investigate the causes of, and identify and implement corrective actions to reduce or eliminate effluent toxicity. If the discharge demonstrates a pattern of toxicity exceeding the numeric toxicity monitoring trigger, the Discharger is required to initiate a Toxicity Reduction Evaluation (TRE) in accordance with an approved TRE workplan. The numeric toxicity monitoring trigger is a benchmark used to determine if additional evaluation is needed, such as accelerated chronic toxicity monitoring and the need to initiate a TRE. The current numeric trigger has been established at 8 TUc (where TU_C = 100/NOEC). The numeric trigger will be reconsidered in the permit renewal. One option is to calculate maximum daily and average monthly triggers rather than establish a single trigger.

If acute or chronic toxicity is allowed in the effluent, appropriate acute and/or chronic mixing zones will need to be defined.

[30] Order No. WQO 2008-0008, pages 6-7


MAP FEATURES
Delta Subareas as described in 2006 CWA Section 303(d) List
Stockton DWC
Delta Southern
Delta Western
Delta Northwestern
Delta Northern
Delta Export Area
Delta Eastern
Delta Central
Delta Boundary
Location Map
Yolo Co.
Sacramento
I Street Bridge
Sacramento Co.
Freeport
Sacramento Regional Wastewater Treatment Plant Discharge
Clarksburg
Greene's Landing/ Hood
Courtland
Yolo Bypass
Cosumnes River
Solano Co.
Amador Co.
Ryde
Walnut Grove
South Fork Mokelumne River
Thornton
Rio Vista
Isleton
Sacramento
Mokelumne River
Lodi
Emmaton
Collinsville
Chipps Island
Pittsburg
Antioch
CCWD PP#1 Intake
City of Stockton Delta Water Supply Project Intake
San Joaquin
Calaveras River
San Joaquin River at Stockton
Stockton
Brentwood
Old
Middle River
CCWD Los Vaqueros PP Intake
Contra Costa Co.
Byron
CCWD Alternative Intake
San Joaquin Co.
Delta Pumping Plant Headworks
Delta Mendota Canal Headworks
Grant Line Canal
River
Manteca
Alameda Co.
Water Quality Impacts Assessment Locations
SRWTP Percent Effluent Assessment Locations
Cities
0 2.5 5
Miles